Diagram from and for Collaboration

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External representations

- Cognitive tools to augment mind

External representations

- Cognitive tools to augment mind
  - Increase memory
  - Facilitate information processing
  - Foster collaboration

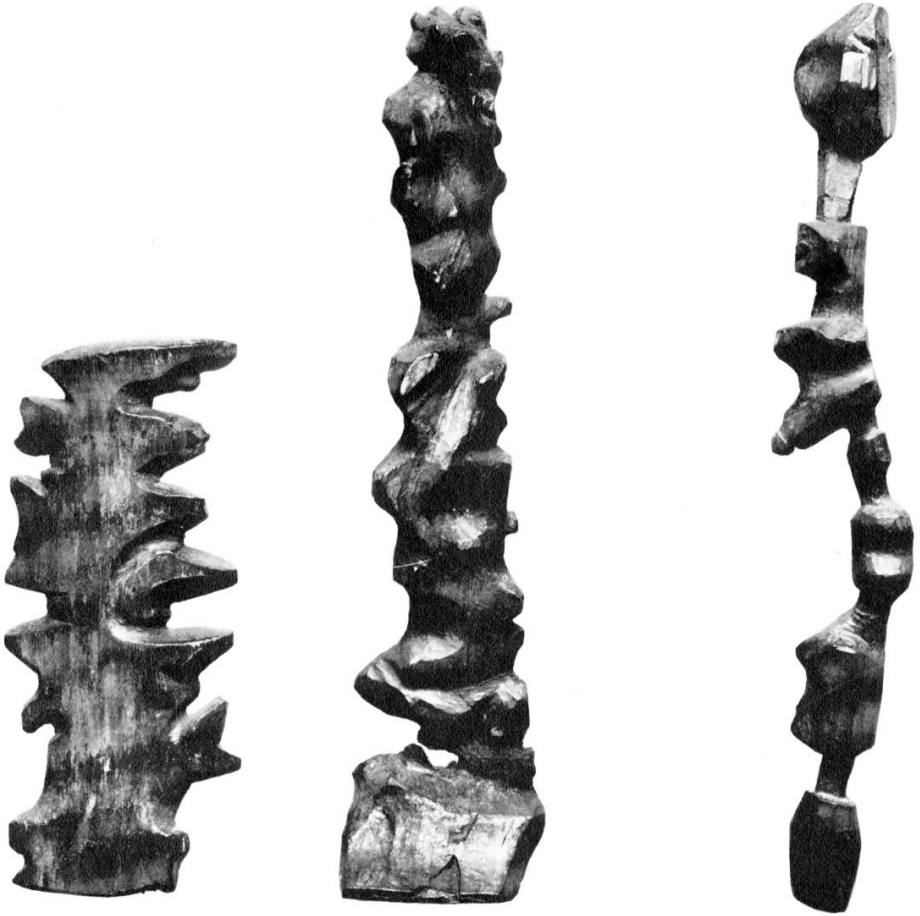
External representations

- Cognitive tools to augment mind
  - Increase memory
  - Facilitate information processing
  - Foster collaboration
- Uniquely human

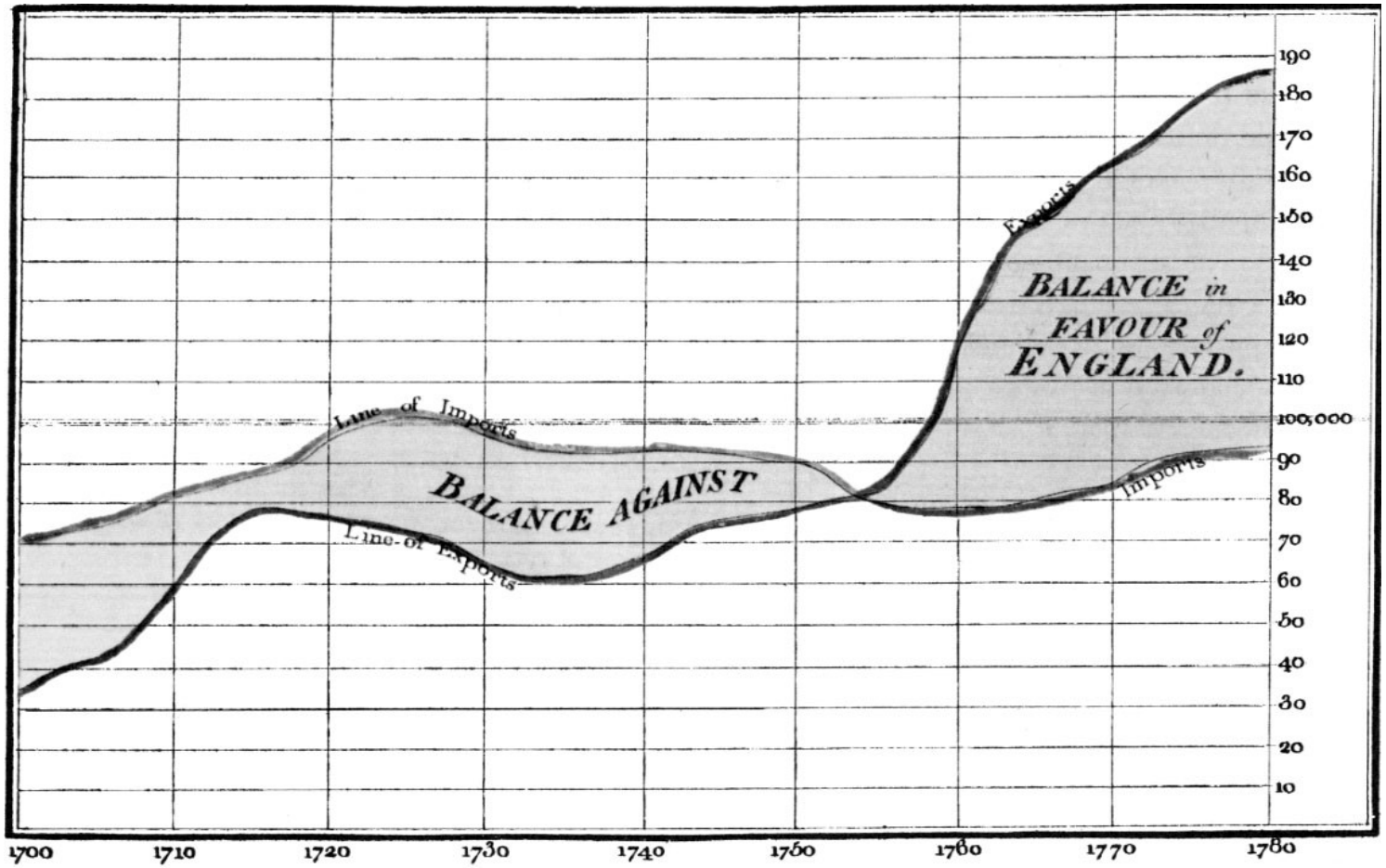
Two kinds of diagrams

- Inherently visuospatial
  - Ancient
  - Maps
- Metaphorically visuospatial
  - Modern, 18th c.
  - Graphs

Eskimo coastal map



Balance of Payments Against and in Favor of England



Diagrams

- Elements
- Spatial relations

Spatial Relations

- Categorical
- Ordinal
- Interval

Spatial relations

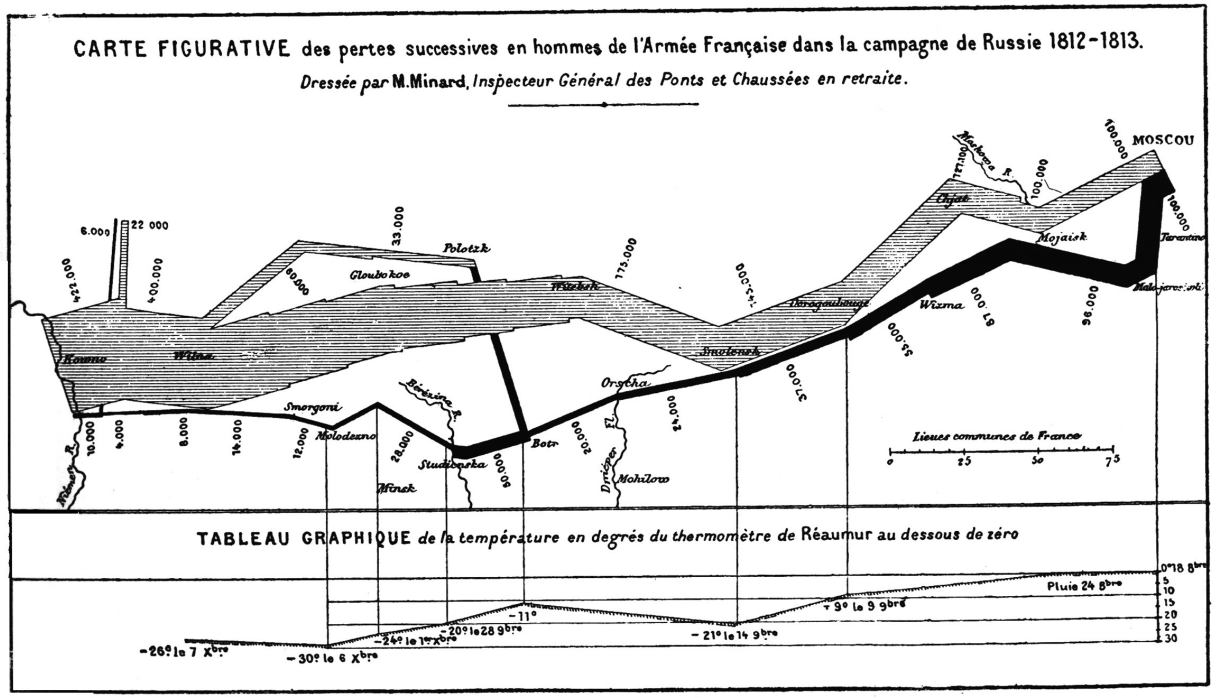
- **Categorical**
  - Spaces between words
  - Frames, boxes
  - Bar graphs

Spatial relations

- **Interval**
  - Children by age, alphabet
  - Grocery list by aisle
  - Anything by preference, ability, cost,
  - Hierarchical trees

  Vertical loaded; up is better, more, stronger

Mixing spatial metaphors



Xbre = December 9bre = November 8bre = October

Spatial relations

- **Interval (ratio)**
  - Graphs

Elements

- Iconic
- Metaphoric (figures of depiction)
- Schematic

Meaningful abstract forms

- E. g., lines, crosses, arrows, blobs
- Cf. classifiers
- Context-specific meanings
- Meanings related to mathematical properties

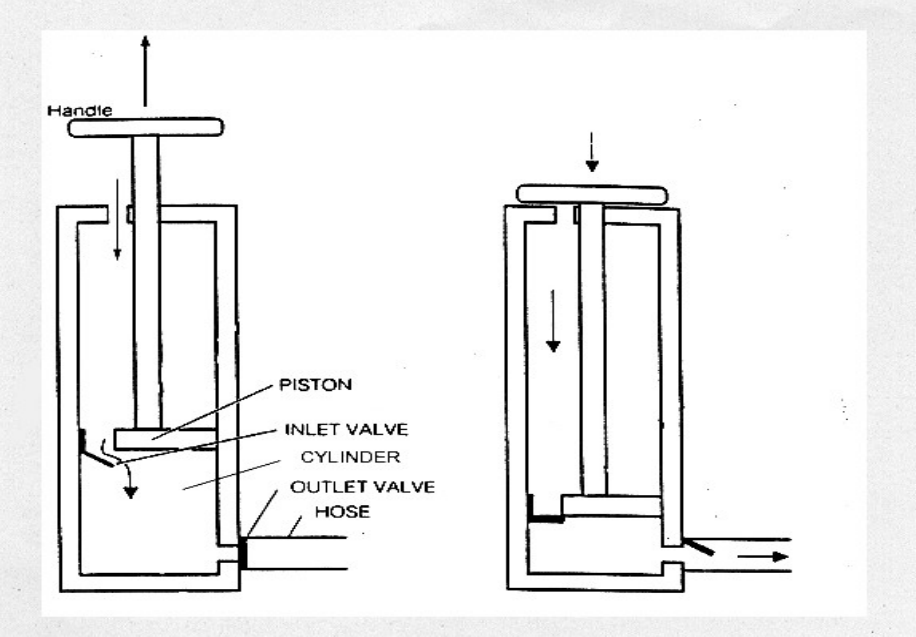
Meanings:
simple, efficient, neutral, abstract

- Line: 1-D, path, link
- Cross: intersection of 2 paths
- Arrow: asymmetric path
- Blobs: enclosure, area

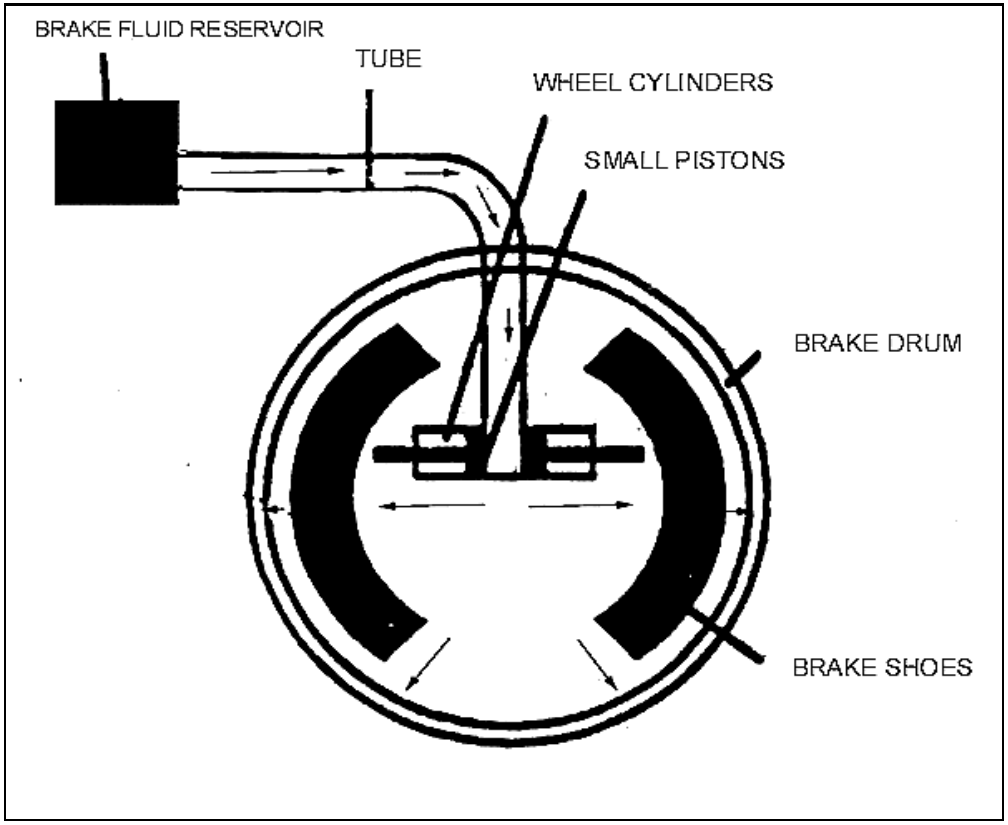
Meaningful abstract forms

- **Arrows** in mechanical diagrams
- **Bars** and **lines** in graphs
- **Curves, lines, crosses**, & **blobs** in route maps

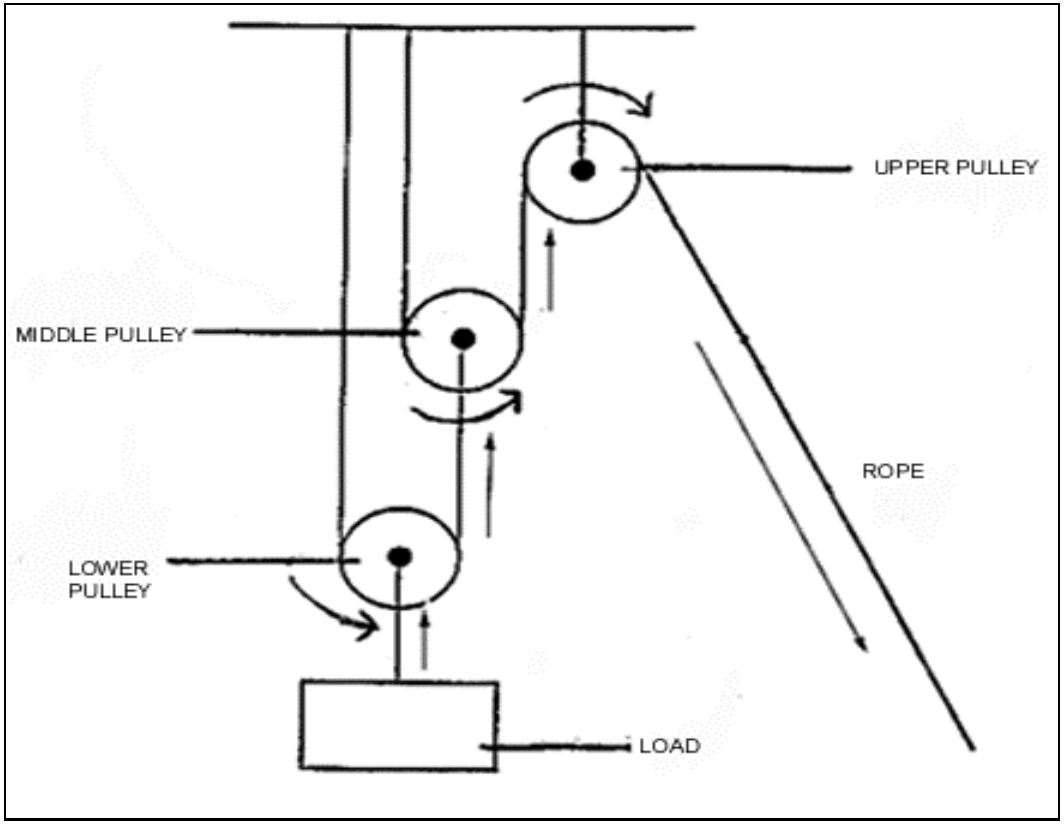
Bicycle pump with arrows



Car brake with arrows



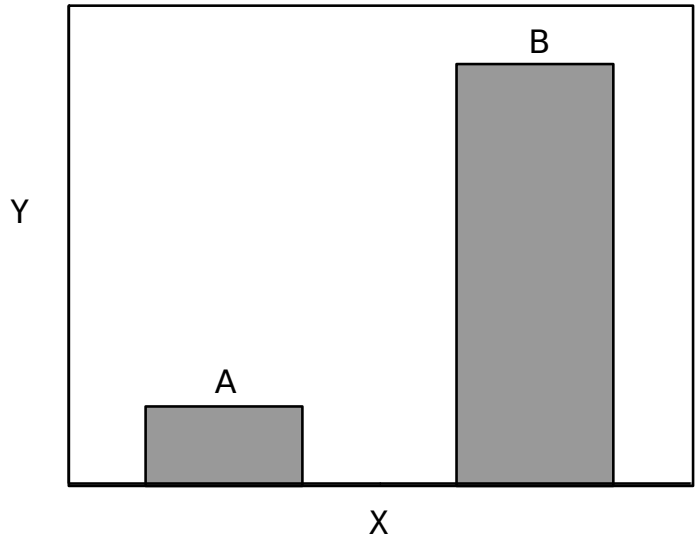
Pulley system with arrows

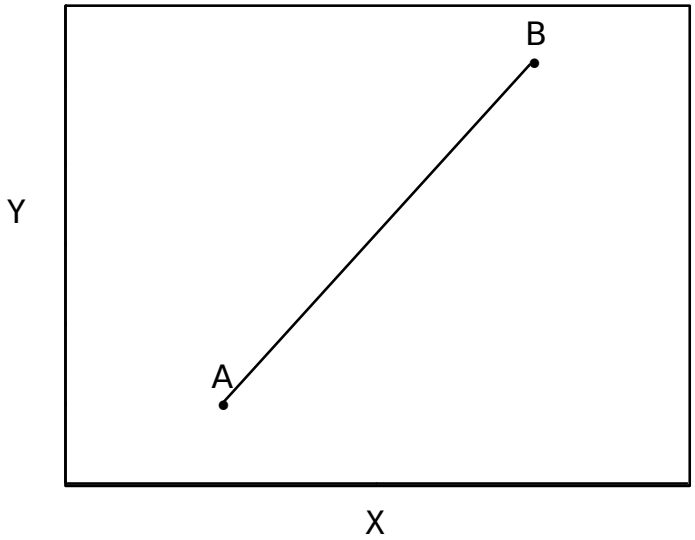


Arrows: temporal to causal reasoning

- Arrows in graphs elicit functional more than structural descriptions
- Functional descriptions elicit more graphs with arrows than structural descriptions
- People readily infer causal sequence from temporal sequence

Producing Descriptions from Graphs



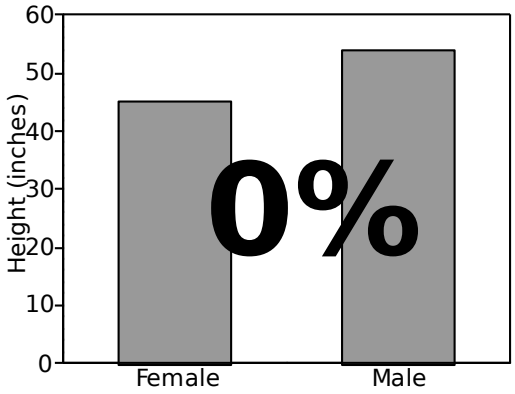
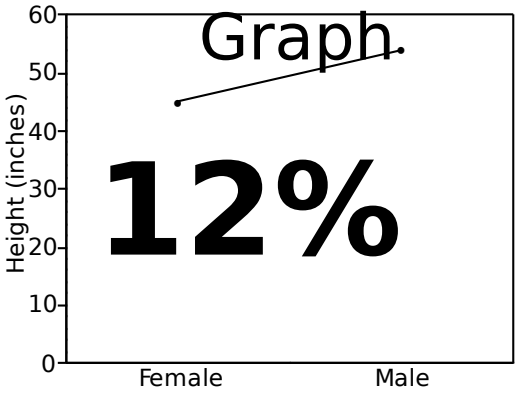
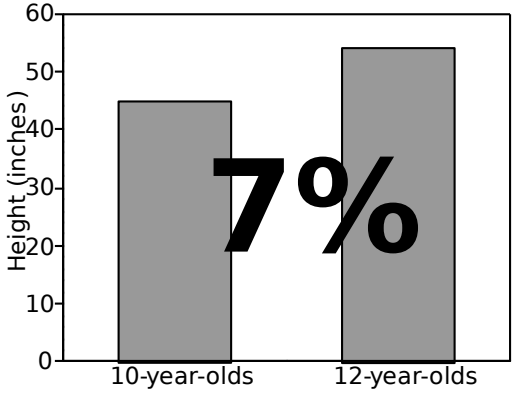
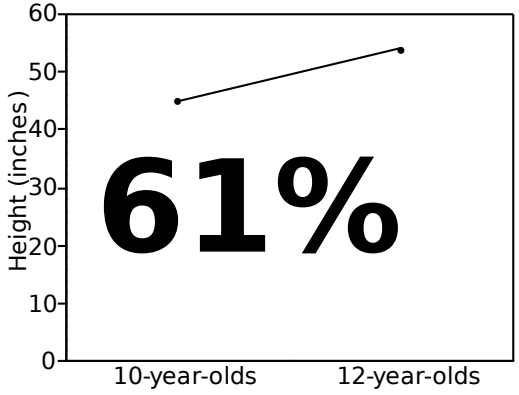


Please describe in a sentence what is shown in the graph above:

Two Categories of Description

- Discrete
  - higher—lower
  - greater—less
  - more—fewer
  - stronger—weaker
- Trend
  - rising—falling
  - increasing—decreasing
  - function
  - relationship
  - trend

Proportion of Trend Responses

	Bar Graph	Line Graph
Discrete Domain		
Continuous Domain		

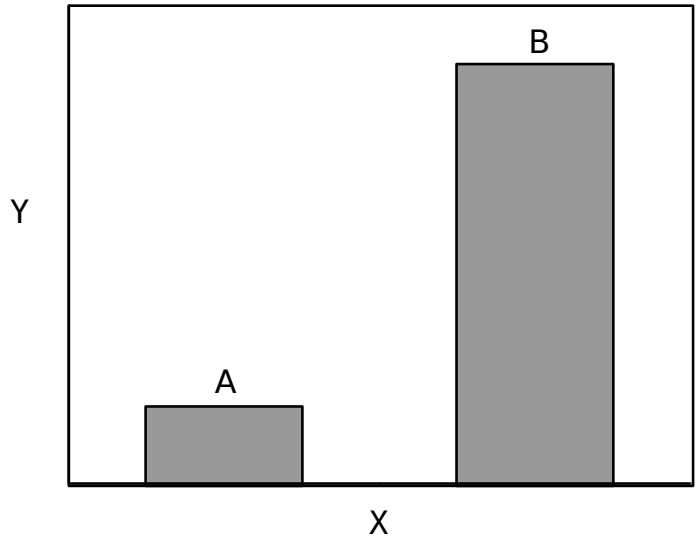
Producing Graphs from Descriptions

	Discrete Description	Trend Description
Discrete Domain	Height for males is greater than for females.	Height increases from females to males.
Continuous Domain	Height for 12-year-olds is greater than for 10-year-olds.	Height increases from 10-year-olds to 12-year-olds.

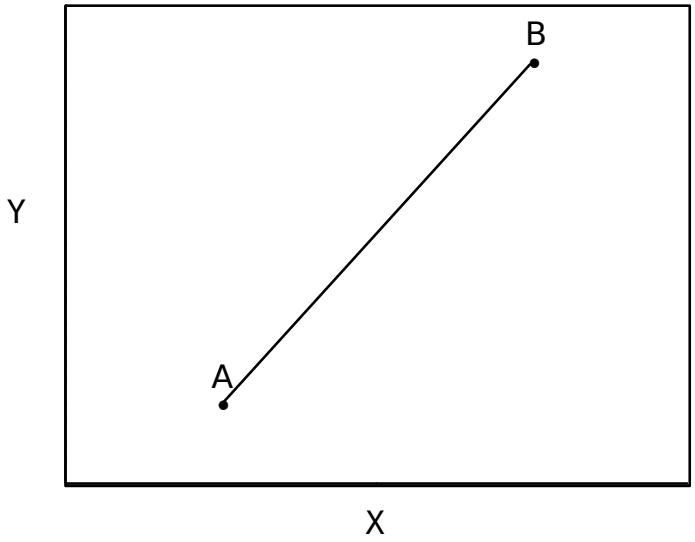
Proportion of Line Graphs

	Discrete Description	Trend Description
Discrete Domain	Height for males is greater than for females. **30%**	Height increases from females to males. **65%**
Continuous Domain	Height for 12-year-olds is greater than for 10-year-olds. **56%**	Height increases from 10-year-olds to 12-year-olds. **100%**

Proportion of Trend Responses



0%



100%

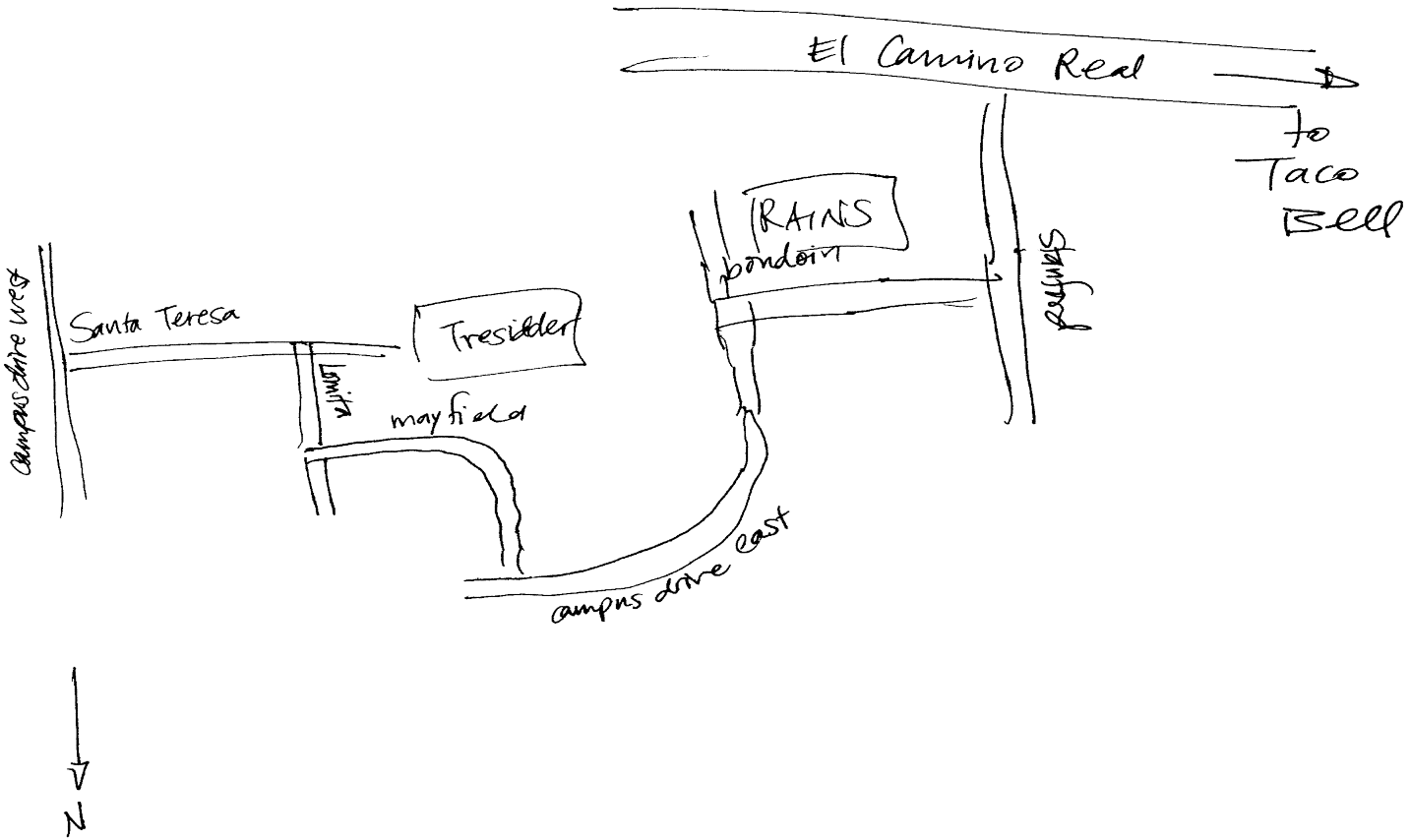
Bars and Lines: Summary

- Interpretations: bars as discrete comparisons, lines as trends
- Productions: discrete comparisons yield bars; trends yield lines
- Despite conflicting real-world domain

Route Maps & Route Directions

- Are the schematizations similar?
- Ask students outside dorm how to get to Taco Bell

Original Map 1



Original Map 2

Directions 1

- From Roble parking lot
- R onto Santa Theresa
- L onto Lagunita (the first stop sign)
- L onto Mayfield
- R onto Bowdoin
- L onto Stanford Ave
- R onto El Camino
- go down a few miles. It’s on the right.

Directions 2

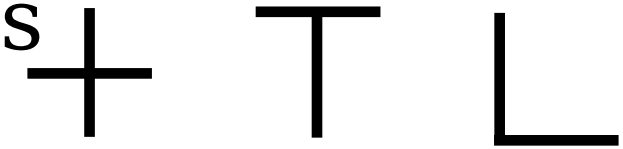
Go down street toward main campus (where most of the buildings are as opposed to where the fields are) make a right on the first real street (not an entrance to a dorm or anything else). Then make a left on the 2nd street you come to. There should be some buildings on your right (Flo Mo) and a parking lot on your left. the street will make a sharp right. Stay on it. That puts you on Mayfield Rd. The first intersection after the turn will be at Campus Dr. Turn left and stay until you get to El

Segmentation according to Denis

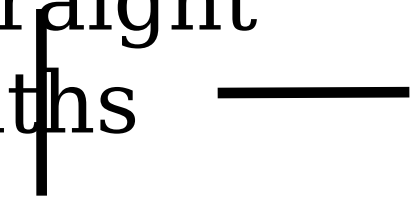
- Start point: “you leave the building”
- Reorientation: “you turn left”
- Path/progression: “you follow Main St.”
- End point: “until you get to the restaurant”

Depictive Toolkit

- Intersections



- Straight Paths



- Curved Paths

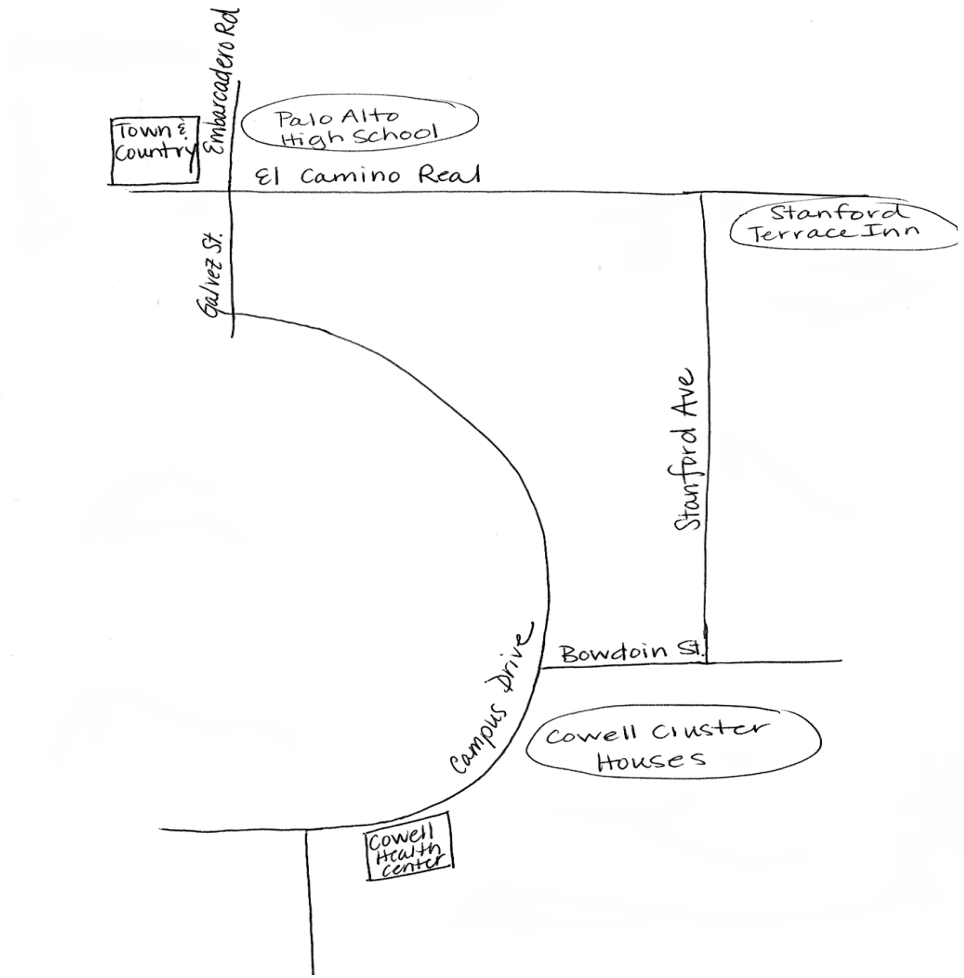
- Landmarks

- Arrows

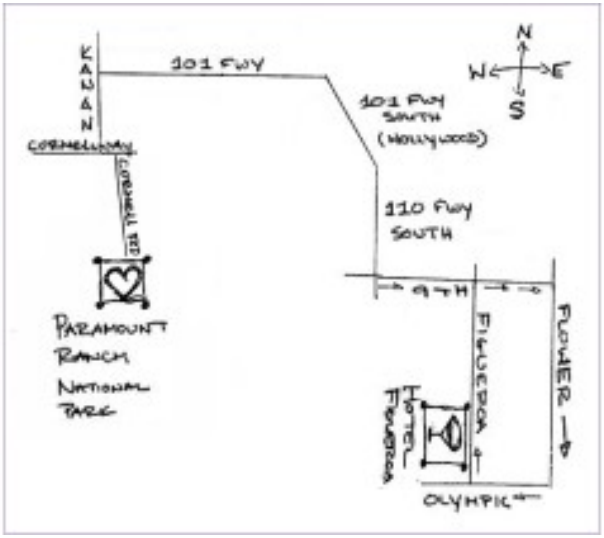
Descriptive Toolkit

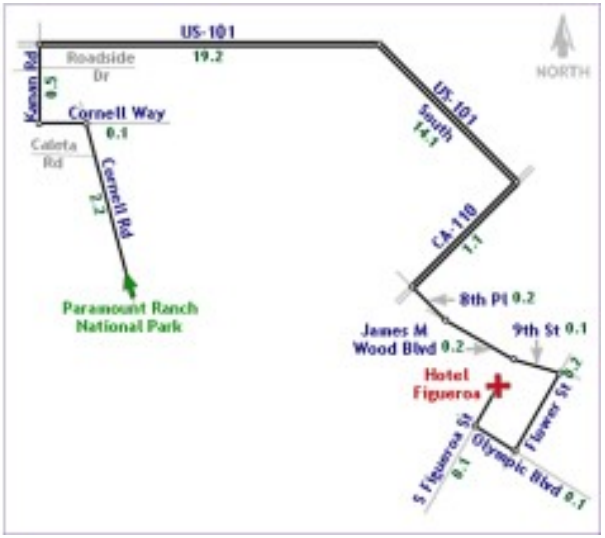
- Start at A facing B
- Turn R/L, turn R/L on (x)
- Go down (x), go down (x) until, go down (x) for (y)
- Follow, follow until (x), follow (x) for (y)
- Continue past
- Z will be on your L/R

Toolkit Map 1



Mapblast.com (Agrawala & Stolz)





Language-like effects of elements

- Schematic
  - Not iconic
  - Gestalt
- Categorical
  - Not analog
- Combinatoric

Why do diagrams communicate effectively?

- Spatial inferences easy (e. g., proximity)
- Spatial metaphors available (e. g., time, value, strength)
- Elements interpretable (icons, figures of depiction, schematic abstract forms)

Constructed by longterm collaboration in communication